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COMMUNICATION APPARATUS, METHOD AND SYSTEM FOR A SELF-CONTAINED BREATHING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of Invention

This invention relates to communications systems, and more particularly, to methods and apparatus for communicating while wearing a self-contained breathing apparatus.

2. Description of Related Art

Communication between fire fighters wearing a self-contained breathing apparatus, such as a face mask, for example, is extremely difficult under the best conditions and almost impossible in most fire situations. Fire fighters must yell through their masks or use elaborate hand signals, or in some cases, may even remove their mask, just to be able to talk to each other. Since fire fighting often requires split-second decision making, often with serious consequences at stake, there is a need for rapid and coherent communication to avoid exposing fire fighters and the public to undue risk.

Existing mechanisms typically employ a microphone which is "push-to-talk" activated and coupled via an interface box and corded link to a speaker placed in proximity to a wearer's ear, thereby providing a walkie-talkie type arrangement. A wearer of the self-contained breathing apparatus must push a button to talk into the microphone, which requires that the wearer can only have one hand free while talking into the apparatus. Moreover, a voice signal picked up by the microphone is usually amplified to be presented to a speaker of another user, which often picks up interference in the form of ambient noise encountered in most fire situations. This interference can cause false triggering of voice detection circuitry. In addition, the geometry of the cavity inside the self-contained breathing apparatus enhances low frequencies,

making the wearer's voice virtually unintelligible when transmitted to a remote user. The cord connecting the microphone and speaker to the interface box can often frustrate a user as it can become entangled in other fire fighting equipment or the user's clothes, or it may loosen and become detached, preventing communication between fire fighters. In short, the cord can be a safety hazard. In addition, the absence of communication with a fire fighter may indicate that the fire fighter is in a dangerous situation and that the other members of the crew should locate and help the person in need, possibly in a smoke-filled room with zero visibility.

SUMMARY OF THE INVENTION

In accordance with one aspect of the invention, there is provided a transmitter apparatus. The transmitter apparatus includes a microphone operable to produce electrical signals representing acoustic utterances, a transmitter circuit in communication with the microphone and operable to transmit electromagnetic radiation representing the acoustic utterances for reception by a receiver, a housing having first and second opposite end portions and a retention portion between the first and second opposite end portions, the retention portion being operable to co-operate with a receptacle on a breathing apparatus to facilitate installation into the breathing apparatus and removal of the transmitter apparatus from the breathing apparatus.

The transmitter apparatus may also include a compensator for compensating for distortions made to the acoustic utterances. The compensator may filter the utterances made by the wearer. The compensator may include a compensator circuit for electrically compensating for the distortions.

The microphone of the transmitter apparatus may be on one of the first and second opposite end portions of the housing.

The transmitter apparatus may further include power terminals for cooperating with a power source to permit the power source to provide energy for powering the transmitter. The power terminals may be inside the housing. The apparatus may include a charging port for receiving energy supplied externally to the housing and for providing the energy to the power terminals. The charging port may include a charging socket on an end of the housing and opposite the end on which the microphone is located.

The retention portion of the transmitter apparatus may be curved and may be concave. The retention portion may have a leading edge and a trailing edge, the leading edge being thicker than the trailing edge. The retention portion may also have a wedge-shaped cross section.

The housing of the transmitter apparatus may be modular, and the breathing apparatus may have a receptacle for receiving and holding the housing therein.

In accordance with another aspect of the invention, there is provided a system including a transmitter apparatus as described above and further including a receiver operable to be supported by a wearer of the breathing apparatus and operable to audibly broadcast a reproduction of acoustic utterances in response to receipt of the electromagnetic radiation at the receiver. In such a system, the receiver may be operable to produce signals representing the acoustic utterances in response to the electromagnetic radiation and the system may further include a repeater operable to re-transmit a representation of the utterances to a remote receiver.

In accordance with another aspect of the invention, there is provided a transmitter apparatus which includes a device for producing electrical signals representing acoustic utterances, a device in communication with the device for producing, for transmitting electromagnetic radiation representing the

acoustic utterances for reception by a receiver, a device for housing the device for producing and the device for transmitting, and a device for retaining the device for housing in a receptacle on a breathing apparatus to facilitate installation of the transmitter apparatus into the breathing apparatus and to facilitate removal of the transmitter apparatus from the breathing apparatus.

In accordance with another aspect of the invention, there is provided a method of facilitating communications for a wearer of a breathing apparatus. The method includes transmitting from a transmitter on the breathing apparatus electromagnetic radiation representing acoustic utterances made by the wearer of the breathing apparatus for reception by a receiver supported by the wearer, and audibly broadcasting a reproduction of the acoustic utterances in response to receipt of the electromagnetic radiation at the receiver.

Transmitting may include transmitting from a transmitter mounted in the breathing apparatus. Transmitting may also include transmitting from a removable transmitter mounted in the breathing apparatus.

The method may further include producing signals in response to the electromagnetic radiation and transmitting the signals to a repeater for re-transmission to a remote receiver. The method may further include producing electrical signals in response to the electromagnetic radiation, the electrical signals representing the acoustic utterances, and the method may include filtering the signals to correct for distortions.

In accordance with another aspect of the invention, there is provided an apparatus facilitating communications for a wearer of a breathing apparatus. The apparatus includes a device on the breathing apparatus for transmitting electromagnetic radiation representing acoustic utterances made by the wearer of the breathing apparatus for reception by a receiver supported by the

wearer, and a device for audibly broadcasting a reproduction of the acoustic utterances in response to receipt of the electromagnetic radiation at the receiver.

In accordance with another aspect of the invention, there is provided a method of facilitating communications between wearers of a breathing apparatus and a listener within a range of at least one of the wearers of the breathing apparatus. The method includes transmitting from a transmitter on the breathing apparatus electromagnetic radiation representing acoustic utterances made by at least one wearer of a breathing apparatus, for reception by a plurality of receivers supported by respective wearers within a range, and audibly broadcasting a reproduction of the acoustic utterances in response to receipt of the electromagnetic radiation at at least one of the receivers.

In accordance with another aspect of the invention, there is provided a system for facilitating communications between wearers of a breathing apparatus and a listener within a range of at least one of the wearers of the breathing apparatus. The system includes a device on the breathing apparatus for transmitting electromagnetic radiation representing acoustic utterances made by at least one of the wearers of the breathing apparatus, for reception by a plurality of receivers supported by respective wearers within the range. The system further includes a device for audibly broadcasting a reproduction of the acoustic utterances in response to receipt of the electromagnetic radiation at at least one of the receivers.

In accordance with another aspect of the invention, there is provided a system for facilitating communications between wearers of a breathing apparatus and a listener within a range of at least one of the wearers of the breathing apparatus. The system includes a device for transmitting from a transmitter on the breathing apparatus electromagnetic radiation representing acoustic

utterances made by at least one of the wearers of the breathing apparatus, for reception by a plurality of receivers supported by respective wearers within the range. The system also includes a device for audibly broadcasting a reproduction of the acoustic utterances in response to receipt of the electromagnetic radiation at at least one of the receivers.

In accordance with another aspect of the invention, there is provided a system for facilitating communications between wearers of a breathing apparatus and a listener within a range of at least one of the wearers of the breathing apparatus. The system includes a plurality of transmitters held in respective receptacles in respective breathing apparatuses for transmitting electromagnetic radiation representing acoustic utterances made by at least one of the wearers, and a plurality of receivers supported by respective wearers, for receiving electromagnetic radiation representing acoustic utterances from at least one of the transmitters. The system also includes a plurality of speakers supported by the respective wearers, the speakers being controlled by respective receivers to audibly broadcast a reproduction of the acoustic utterances represented by the electromagnetic radiation transmitted by at least one of the transmitters.

In accordance with one aspect of the invention, there is provided a method of communicating the occurrence of an event indicated by a pre-defined audio signal. The method involves detecting a first pre-defined audio signal, and transmitting a pre-defined radio frequency signal in response to detection of the first pre-defined audio signal.

The method may involve wearing a detector capable of detecting the first pre-defined audio signal and wearing a transmitter capable of transmitting the pre-defined radio frequency signal.

The method may involve transmitting a message indicative of the occurrence of the event. Transmitting may further involve or alternatively involve transmitting a homing signal.

The method may involve detecting the event and producing the first pre-defined audio signal in response to detection of the event.

The method may involve wearing a detector operable to detect the event.

The method may involve producing a second pre-defined audio signal in response to receiving the first pre-defined radio frequency signal and producing the second pre-defined audio signal may involve producing a synthesized voice message.

In accordance with another aspect of the invention, there is provided an apparatus for communicating the occurrence of an event indicated by a pre-defined audio signal. The apparatus may involve provisions for detecting a first pre-defined audio signal and provisions for transmitting a pre-defined radio frequency signal in response to detection of the first pre-defined audio signal.

The apparatus may include provisions to facilitate wearing the provisions for detecting the first pre-defined audio signal and the provisions for transmitting.

The provisions for transmitting may be operable to transmit a message indicative of the event and/or may be operable to transmit a homing signal.

In accordance with another aspect of the invention, there is provided a system involving the apparatus above and further involving provisions for detecting the event and provisions for producing the first pre-defined audio signal in

response to detection of the event. The system may involve provisions facilitating wearing of the provisions for detecting the event.

In accordance with another aspect of the invention, there is provided a system involving the apparatus above and further involving provisions for producing a second pre-defined audio signal in response to receiving the first pre-defined radio frequency signal. The provisions for producing the second pre-defined audio signal may involve provisions for producing a synthesized voice message.

In accordance with another aspect of the invention, there is provided an apparatus for communicating the occurrence of an event indicated by a pre-defined audio signal. The apparatus includes a detector operable to detect a first pre-defined audio signal and a transmitter operable to transmit a pre-defined radio frequency signal in response to detection of the first pre-defined audio signal.

The apparatus may include a strap connected to the detector and the transmitter to facilitate wearing the detector and the transmitter on a person.

The transmitter may be operable to transmit a message indicative of the event and/or transmit a homing signal.

In accordance with another aspect of the invention, there is provided a system involving the apparatus above and further involving an event detector and an audio signal generator in communication with the event detector for generating the first pre-defined audio signal in response to detection of the event.

A strap may be connected to the event detector and the audio signal generator to facilitate wearing the event detector and the audio signal generator on a person.

In accordance with another aspect of the invention, there is provided a system involving the apparatus above and further involving a second audio signal generator for generating a second audio signal in response to receipt of the first pre-defined radio signal. The second audio signal generator may include a voice synthesizer for producing a voice synthesized message.

In accordance with another aspect of the invention, there is provided a method of facilitating communications for a wearer of a mask. The method may include receiving a removable transmitter apparatus in a receptacle in the mask, to permit the transmitter apparatus to receive utterances made by the wearer of the mask and to transmit electromagnetic radiation representing the utterances for reception by a receiver. The method may further include frictionally engaging the removable transmitter apparatus in the receptacle to hold the removable transmitter apparatus therein.

Receiving the transmitter apparatus may include receiving the transmitter apparatus in the receptacle on a user-facing side of the mask. Receiving may also include receiving the transmitter apparatus between a breathing valve and a chin seal defining the receptacle in the mask. A portion of the chin seal may be received between opposite end portions of the transmitter apparatus. Receiving may also include receiving a portion of the chin seal in a concave portion of the transmitter and/or receiving a portion of the chin seal adjacent a curved portion of the transmitter.

Other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of

specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

In drawings which illustrate embodiments of the invention,

Figure **1** is a fragmented side view of a breathing apparatus fitted with a transmitter apparatus according to a first embodiment of the invention;

Figure **2** is a perspective view of the transmitter apparatus shown in Figure **1**;

Figure **3** is a fragmented side view of a breathing apparatus incorporating *the transmitter apparatus shown in Figure 2*;

Figure **4** is a block diagram of a transmitter circuit contained within the transmitter apparatus shown in Figure **2**;

Figure **5A** is a block diagram of a receiver circuit for receiving transmissions produced by the transmitter apparatus of Figure **2**;

Figure **5B** is a flowchart of routines executed by a processor circuit shown in Figure **5A**;

Figure **6A** is a perspective view of a prior art "man down" prior art sensing unit;

Figure **6B** is a front view of a receiver housing for housing the receiver shown in Figure **5A**;

Figure **7** is a schematic representation of a system in which a plurality of the transmitters shown in Figure **2** and the receivers shown in Figure **6** are employed; and

Figure **8** is a block diagram of a repeater operable to be used with the transmitter shown in Figure **2**.

DETAILED DESCRIPTION

Referring to Figure **1**, an apparatus according to a first embodiment of the invention is shown generally at **10**. The apparatus includes a self-contained breathing apparatus shown generally at **12** and a transmitter apparatus **13** which is received within the self-contained breathing apparatus **12**. In this embodiment, the self-contained breathing apparatus **12** is in the form of a fire fighter's mask having a rubber face shield **16**, a lens **18**, a breathing valve **20** and a rubber chin seal **22**. The rubber chin seal **22** is flexible and has a curved portion shown generally at **24** that fits relatively snugly on the chin of a wearer. A receptacle **26** is formed on a user-facing side **25** of the breathing apparatus between the chin seal **22** and a flexible tab **28** protruding into the mask from the breathing valve **20**. The transmitter apparatus **13** is a removable device that is received in the receptacle **26** in the breathing apparatus **12** to permit the transmitter apparatus **13** to receive acoustic utterances made by the wearer of the mask and to transmit electromagnetic radiation representing the acoustic utterances for reception by a receiver.

Referring to Figure **2**, a transmitter apparatus **14**, according to a second embodiment of the invention, has a housing shown generally at **30** having first and second opposite ends **32** and **34** with a retention portion shown generally at **36** therebetween.

Referring to Figure **3**, the retention portion **36** is operable to co-operate with the receptacle **26** of the breathing apparatus **12** to facilitate installation and

removal of the transmitter apparatus **14**. In the embodiment shown in Figures **2** and **3**, the retention portion **36** is concavely curved and has a leading edge **38** and a trailing edge **40**, the leading edge being thicker as shown by dimension arrow **42**, than the trailing edge as shown by dimension arrow **44**. Referring to Figure **3**, the leading edge **38** faces outwardly, away from the wearer and the trailing edge **40** faces inwardly, while the chin seal **22** is received on the retention portion **36** and between the opposite end portions **32** and **34** of the transmitter apparatus as shown in Figure **2**, and thus prevents side-to-side movement of the transmitter apparatus **14** in the breathing apparatus **12**. A wedge effect and friction fit of the housing **30** shown in Figure **2**, between a rubber lower portion **43** of the mask and the chin seal **22** prevent vertical movement of the transmitter apparatus. Thus, the transmitter apparatus **14** is relatively snugly held within the breathing apparatus **12** but is easily removed by simply pulling the chin seal **22** back in the direction shown by arrow ***45*** *and simply removing the transmitter* apparatus from the receptacle **26**. Installation of the transmitter apparatus is achieved by following the above steps in reverse order. Thus, it will be appreciated that the transmitter apparatus **14** is easily installed and easily removed from the breathing apparatus.

Easy removal and installation of the transmitter apparatus **14** in the manner described is advantageous because it allows the transmitter apparatus to be removed from the mask after use and conveniently disinfected and electrically charged for subsequent use. Furthermore, it requires no modifications to existing popular breathing apparatuses. Thus, the device is a convenient retrofit item. In addition, since the transmitter apparatus is installed in the breathing apparatus, the breathing apparatus itself blocks ambient noise outside the breathing apparatus from reaching the transmitter apparatus and thus background noise in transmissions made by the transmitter apparatus is relatively quiet.

The transmitter apparatus **14** may be stored in a charger (not shown), for example, and as a fire crew suits up to attend a fire, a fire fighter may grasp the breathing apparatus **12** in one hand and grasp the transmitter apparatus **14** in the other hand and while walking, or while stationary, simply insert the removable transmitter apparatus in the receptacle **26** in the breathing apparatus in the position shown in Figure **3**. Similarly, when the wearer is finished with the apparatus, the transmitter apparatus **14** may be easily removed and replaced back into the charger. To facilitate this use of the transmitter apparatus **14**, it is desirable that a plurality of modular transmitting units having the general shape shown in Figure **2**, for example, be used, so that transmitter apparatus are interchangeable between breathing apparatus of a given type, thus eliminating any requirement for a particular transmitter to be matched with a particular mask.

Transmitter apparatus ***14***

Referring to Figure **4**, a block diagram of the transmitter apparatus **14** is shown generally at **50**. The transmitter apparatus **14** includes a microphone **52** that receives acoustic utterances made by a wearer of the breathing apparatus and produces electrical signals which are received by an amplifier **54**. Electrical signals are also provided to a voice detection circuit **56** which supplies a detect signal to a microprocessor **58** which produces an enable signal that is provided to the amplifier **54** and to a modulator **60** in communication with the amplifier **54**. Installation of the transmitter apparatus in the breathing apparatus reduces ambient noise in the vicinity of the wearer reaching the microphone **52** and thus false or unwanted activities of the voice detection circuit **56** are reduced.

In this embodiment, the amplifier **54** is in communication with the modulator **60** through a voice compensator **62** that compensates for distortions made to the acoustic utterances of the wearer of the breathing apparatus as a result of the cavity formed in the breathing apparatus between the wearer's face and

the lens **18** and other components of the mask. Typically these distortions are manifest as amplified low frequencies and thus in this embodiment the voice compensator **62** includes a voice compensator circuit **63** which may include a filter circuit for attenuating low frequencies and boosting high frequencies. Thus, the voice compensator circuit **63** electrically compensates for distortions created in the breathing apparatus.

Alternatively, compensation for such distortions may be made by including mechanical components such as baffles and the like within the breathing apparatus.

Still referring to Figure **4**, the modulator **60** provides a representation of the acoustic utterance modulated on a radio frequency carrier signal which is provided to an antenna **64** operable to radiate electromagnetic radiation representing the acoustic utterances, *for reception by a receiver as shown in* Figure **5A** and/or Figure **8**. In the embodiment shown, the electromagnetic radiation produced by the antenna is at a carrier frequency of approximately **915** MHz but could be produced at other carrier frequencies using known techniques.

Still referring to Figure **4**, in the embodiment shown the transmitter apparatus **14** further includes a rechargeable battery **66** for supplying power to power conductors **68** and **70** that distribute power to the amplifier **54**, voice detection circuit **56**, microprocessor **58**, modulator **60** and voice compensator circuit **63**, respectively.

The transmitter apparatus **14** also includes a power receptacle **72** having first and second power terminals **74** and **76** that are in communication with a charging circuit **78** which is connected to the battery **66**. This enables an external device to supply power through the terminals **74** and **76** to the charging circuit **78** to recharge the battery **66**. The charging circuit **78** may

include a diode. Alternatively, non-rechargeable power sources such as alkaline batteries may be used and the charging circuit **78** may be disabled for use with such non-rechargeable sources.

Referring back to Figure **2**, in the embodiment shown the microphone **52** is situated on the first end portion **32** of the housing **30** and a charging port **55** is located on the opposite end portion **34** of the housing. The charging port **55** includes a charging socket **57**. The terminals **74** and **76** shown in Figure **4** are located within an opening in the charging socket **57**, but within the housing.

Receiver

Referring to Figure **5A**, a receiver according to a first embodiment of the invention is shown generally at **80**. The receiver includes an antenna **82**, a receiver block shown generally at **84**, and a transmitter block shown generally at **86**. A processor circuit **88** controls components of the receiver block **84** and the transmitter block **86** such that generally only one of these blocks is active at any given time.

The receiver block **84** includes a demodulator **90** for demodulating signals received at the antenna **82** into baseband signals which are provided to an amplifier **92** which amplifies the baseband signals and provides them to a filter **94**, which ultimately causes signals to be provided to a speaker **96**. Thus, the electromagnetic radiation received from the transmitter apparatus shown in Figures **1**, **2** or **3** is received at the antenna **82** of the receiver and demodulated so that a reproduction of the acoustic utterances originally detected by a transmitting transmitter apparatus **14** is broadcast on the speaker **96**. This is the normal mode of operation and thus the speaker **96** continuously broadcasts a reproduction of the acoustic utterances in response to receipt of electromagnetic radiation from at least one of the transmitters.

The transmitter block **86** of the receiver includes a microphone **100**, an amplifier **102** and a modulator **104**. Referring to Figures **5A** and **5B**, when a push-to-talk switch **199** is actuated, the processor circuit **88**, under the direction of a block **300** of codes, detects that the switch has been actuated. Block **302** then directs the processor circuit **88** to turn on the modulator **104** by activating an output **103** and to turn on the amplifier **102** by activating an output **101** and to turn off the receiver block by disabling the demodulator **90** and amplifier **92** by deactivating outputs **105** and **107**, respectively. Block **303** directs the processor circuit **88** to maintain the current state of these devices until the push-to-talk switch **199** is no longer actuated. At that time, block **304** directs the processor circuit **88** to turn off the transmitter amplifier **102** and modulator **104** by deactivating outputs **101** and **103**, respectively, and to activate the outputs **105** and **107** to turn on the demodulator **90** and the amplifier **92**, respectively, to enable reception of radio signals.

The processor circuit **88** is also controlled by blocks of code that direct the processor circuit to detect the occurrence of an event such as a "man down" condition. To do this, the receiver **80** is provided with a motion detector **203** and a block **306** of codes that causes the processor circuit **88** to monitor the motion detector to determine when there is no motion. When no motion is detected, the processor circuit **88** is set into a mode in which it listens for a pre-defined audio signal such as the audible signal produced by conventional "man down" sensing units as shown at **89** in Figure **6A**. These units include a detector **91** for detecting a "man down" event and an audio device **93** for emitting an audible siren sound in response to detection of the event. The apparatus **89** may be worn by a user, by employing a strap **95** or clip, for example, to secure the device to the user. Alternatively, the processor may be placed in a polling mode, periodically, for example, in which it enters the listening mode to listen for the predefined audio signal.

When the audible siren sound is detected by the processor circuit **88** a "man down" message is transmitted by the transmitter block of the receiver apparatus. The "man down" message may be a **10**kHz signal encoded on a **918**MHz carrier signal, for example. After the "man down" message is transmitted, a homing signal is transmitted. The homing signal may be useful in situations where the siren sound produced by the standard fire fighting equipment cannot be heard due to noise conditions or excessive distance, for example.

When the processor circuit **88** detects from the motion detector **203** that there is no motion, block **308** directs the processor circuit to enable the amplifier **102** by activating the output **101** while maintaining the modulator **104** disabled, to permit the audible siren sound to be received by the microphone **100**, amplified by the amplifier **102**, and provided to the "man down" detection circuit ***201***. *The "man down" detection circuit **201** has a tone detector circuit* **207** that produces a siren detect signal **109** for receipt by the processor circuit **88** to inform the processor circuit when the siren sound is received at the microphone **100**. In this embodiment, the siren sound has a frequency of **1** kHz. Alternatively, the siren sound may have a frequency in a range of **1-4** kHz or any other suitable frequency or range of frequencies.

On detection of the siren sound, block **310** directs the processor circuit **88** to configure the output **105** to turn off the demodulator **90** and to configure the output **103** to turn on the modulator **104**, *while* supplying the "*man down*" message to the modulator **104** so that a **918** MHz carrier frequency signal modulated with the "man down" message is transmitted by the antenna **82**. In this embodiment, the "man down" message is a signal having a frequency of **10** kHz modulated on the **918** MHz carrier frequency. Alternatively, the "man down" message may have any other suitable frequency or range of frequencies. Block **312** then directs the processor circuit to transmit a

continuous homing signal on the **918** MHz carrier to enable others to home in or locate the man wearing the receiver, i.e. the "man down".

While the siren sound is detected, the processor circuit **88** continues to transmit the **918** MHz homing signal as indicated at block **314**.

A process for receiving an incoming radio signal is shown generally at **316**. The process begins with block **318** that directs the processor circuit **88** to receive signals from the demodulator **90**. The demodulator **90** is normally in a receive mode in which it demodulates radio signals into baseband signals for reception by the amplifier **92** and by the processor circuit **88**.

When a demodulated radio signal is received, a carrier strength signal **317** is produced and this signal is detected by block **318**. Block **320** then directs the *processor circuit **88** to turn on the amplifier **92**, the filter **94** and the speaker* **96**. Block **322** then directs the processor circuit **88** to analyze the demodulated signal to determine whether it includes the "man down" message. If not, then block **324** directs the processor circuit **88** to maintain the amplifier **92**, filter **94** and speaker **96** activated to permit the demodulated signal normally representing the acoustic utterances transmitted as electromagnetic radiation to be audibly reproduced by the speaker **96**.

When no further radio signal is received, the processor is directed to block **326** which causes it to shut off the amplifier **92** and filter **94**, with output **107**, and speaker **96**.

If at block **322**, the "man down" message is detected, block **328** directs the processor circuit **88** to deactivate outputs **105** and **107** to turn off the receiver amplifier **92** and filter **94** and to proceed to block **330** which causes it to produce a synthesized voice signal, for example, as an analog signal, which is provided to a further amplifier **332** for amplification and communication to the

speaker **96**. The synthesized voice signal may utter "MAN DOWN", for example.

Another function of the receiver **80** is to permit the user to actuate a locator function for locating and homing in on the **918** MHz homing signal mentioned above. To do this a block **333** of codes directs the processor circuit **88** to determine whether or not an emergency locator button **335** on the receiver **80** has been actuated. If it has, block **334** directs the processor circuit **88** to monitor the signal strength signal received from the demodulator **90** and block **336** directs the processor circuit **88** to produce a tone signal having a frequency dependent on signal strength and to send this tone to the speaker through the amplifier **332**. This continues until the locator button is actuated again, in which case, as indicated at **338**, the tone signal is no longer produced and applied to the speaker **96**. The frequency of the tone signal may increase as the signal strength increases, for example.

The receiver shown in Figures **5A** and **5B** may be integrated into a housing having an appearance similar to that shown at **120** in Figure **6B**, for example. The speaker is shown generally at **96** and the talk button is shown at **106**, for example. The unit shown is approximately the size of a walkie-talkie and may be supported by a person such as by use of a strap, for example, or by being clipped to the user's clothing such as on a belt, for example. Typically, the user supports the receiver **120** on his person.

Referring to Figure **7**, a plurality of transmitters and receivers of the types described above may be employed to produce a system facilitating communications between wearers of a breathing apparatus and a listener within a range of at least one of the wearers of the breathing apparatus. More particularly, wearers of the breathing apparatus are shown at **150**, **152**, **154** and **156**. These wearers may be fire fighters, for example. The listener is shown generally at **158** and may be an injured occupant of a building on fire.

The injured occupant may be awaiting rescue by one of the fire fighters **150** to **156**. The fire fighters may also be listeners. Each of the fire fighters has his own transmitter apparatus **160**, **162**, **164** and **166**, located in his breathing apparatus and each fire fighter has a receiver **170**, **172**, **174** and **176** supported on his person. When a fire fighter **150** to **156** is in relatively close proximity with another (approximately **200** feet, for example), utterances made by that fire fighter are transmitted as electromagnetic radiation by his respective transmitter apparatus and this electromagnetic radiation is received by each receiver operable to detect it. Each receiver that detects this electromagnetic radiation produces an audio signal that is audibly broadcast by the associated speaker in the receiver. In effect, each of the fire fighters **150** to **156** acts as a speaker holder, the speaker being in the receiver **170** to **176** and thus the system provides a simple mobile public address system over which any of the fire fighters **150** to **156** can broadcast a message. This mobile public address system allows any of the fire fighters to talk to the listener **158**, if necessary, while at the same time allowing each of the remaining fire fighters to also listen to the communication. Consequently, the system provides a mobile public address system enabling communication between fire fighters while at the same time enabling communication between a fire fighter and a listener such as a "man down" or an incapacitated person.

Referring to Figure **8**, the system described above may further include a repeater as shown generally at **200** in Figure **8**. In this embodiment, the repeater **200** includes an interface module shown generally at **202** and a conventional radio such as a very high frequency (VHF) or ultra high frequency (UHF) radio **204** having audio and talk inputs **206** and **208**, respectively. The audio input **206** is operable to receive an audio signal, whereas the talk input is operable to receive a digital signal representing whether or not the radio is to be put into a transmit or receive mode, the transmit mode being one in which a signal received at the audio input **206** is transmitted by the radio **204**.

The interface module **202** includes a receiver **210** comprised of a demodulator **212**, an amplifier **214** and a filter **216** for producing an audio signal operable to be received at the audio input **206** in response to electromagnetic radiation received at a carrier frequency of **915** MHz, for example, in this embodiment. The interface module **202** also includes a control circuit shown generally at **218** comprised of a radio signal detector **220** and a microprocessor **222**. The radio signal detector **220** is operable to receive a signal from the demodulator **212** representing a demodulated version of the electromagnetic radiation received at an antenna **211**. The radio signal detector produces a digital signal at an output **224** representing whether or not a radio signal is detected, and the microprocessor **222** produces a digital signal compatible with the talk input **208**, for controlling the radio **204** to cause the audio signal received at the input **206** to be transmitted on a VHF or UHF frequency. Thus, the interface module **202** effectively supplies a signal and controls the radio **204** to transmit the signal. In the embodiment shown, the audio signal supplied to the radio **204** is derived from electromagnetic radiation received at a carrier frequency of **915** MHz, for example, which includes radiation transmitted by any of the transmitter apparatuses **14** described above. Thus, the repeater **200** acts to receive electromagnetic radiation transmissions from the transmitters **160-166** located in the breathing apparatus **12**, shown in Figures **1** and **3**, to effectively cause audio signals representing utterances made by wearers of the breathing apparatus to be transmitted over conventional radio frequencies for reception by conventional radios. This allows fire fighters, for example, who are wearing the breathing apparatus to communicate with each other and to communicate to listeners in relatively close proximity, while allowing such communications to be retransmitted on conventional radio frequencies to permit conventional radio receivers to monitor such communications.

While specific embodiments of the invention have been described and illustrated, such embodiments are illustrative only and should not be construed as limiting the invention as defined by any claims that may be presented herein or in any corresponding patent application or patent.

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